

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1: (Currently Amended) A method of depositing a ~~nanostucture-containing material~~ composite layer with at least one component being carbon nanotubes onto a substrate, the method comprising:

(i) forming a suspension of ~~pre-formed nanostucture-containing material~~ containing at least the carbon nanotubes and an adhesion promoting material in a liquid medium, ~~the nanostucture-containing material comprising at least one of nanotubes and nanowires;~~

(ii) selectively adding a charger to the liquid medium;

(iii) immersing electrodes in the suspension, wherein at least one of the electrodes comprises the substrate; and

(iv) applying a direct or alternating current to the immersed electrodes thereby creating an electrical field between the electrodes;

wherein the ~~nanostucture-containing material~~ carbon nanotubes and the adhesion promoting material ~~is caused to migrate toward, and attach to, co-deposit on the substrate to form the composite layer, the composite layer having an intimate mix of the carbon nanotubes and the adhesion-promoting material.~~

Claims 2 to 8 (Canceled)

9. (Currently Amended) The method of claim 1, wherein the ~~pre-formed nanostucture-containing material comprises single-walled carbon nanotubes, and the method further comprises shortening the pre-formed single-walled~~ length of the carbon nanotubes by chemical reaction or mechanical processing prior to their introduction into the suspension to improve the dispersion and stability of the suspension.

10. (Original) The method of claim 9, wherein the method further comprises annealing the pre-formed nanotubes at 100°C - 1200°C in a vacuum prior to their introduction into the suspension.

11. (Canceled)

12. (Canceled)

13. (Currently Amended) The method of claim 1, wherein step (i) further comprises either application of ultrasonic energy or stirring thereby facilitating the formation of a stable suspension.

14. (Original) The method of claim 1, wherein the charger comprises at least one of magnesium chloride, $\text{Mg}(\text{NO}_3)_2$, $\text{La}(\text{NO}_3)_3$, $\text{Y}(\text{NO}_3)_3$, AlCl_3 , and sodium hydroxide.

15. (Canceled)

16. (Canceled)

17. (Currently Amended) The method of claim 1 wherein the liquid medium comprises alcohol, ~~the nanostructure-containing material comprises single-walled carbon nanotubes,~~ and step (i) further comprises forming the suspension having a concentration of 0.1-1.0 mg/mL, expressed as mg of ~~single-walled carbon nanotubes~~ per ml of liquid medium.

18. (Original) The method of claim 1, wherein step (iv) comprises applying direct current to the electrodes.

19. (Canceled)

20. (Canceled)

21. (Original) The method of claim 18, wherein step (iv) comprises creating an electrical field between the electrodes of at least 20V/cm in intensity.

22. (Original) The method of claim 1, further comprising the steps of:
(v) removing the electrodes from the suspension; and
(vi) annealing the coated substrate.

23. (Currently Amended) The method of claim 22, wherein step (vi) comprises a two-step anneal, comprising heating the coated substrate to a first temperature for a first selected period of time, then heating the coated electrode to a second temperature for a second selected period of time.

24. (Currently Amended) The method of claim 1, wherein step (i) further comprises adding additional materials into the suspension ~~of pre-formed nanostructure-containing material~~.

25. (Currently Amended) The method of claim 24, wherein the additional materials comprise at least one binder material, wherein the binder material is present in an amount ranging from 0.1-20 weight% of the ~~nanostructure-containing material~~ carbon nanotubes.

26. (Currently Amended) The method of claim 25, wherein the binder material is at least one of poly(vinyl butyral-co vinyl alcohol-co-vinyl acetate) and poly(vinylidene fluoride).

27. (Currently Amended) The method of claim ~~[[24]]~~ 1, wherein the ~~additional materials comprise~~ adhesion promoting material comprises small particles ~~of at least one of: iron; titanium; lead; tin; or cobalt;~~ and wherein the particles have a diameter less than 1 micrometer.

28. (Currently Amended) The method of claim 1, wherein step (iii) further comprises pre-coating at least one adhesion promoting layer onto the substrate prior to coating with the ~~nanostucture-containing materials~~ suspension.

29. (Currently Amended) The method of claim 28, wherein the adhesion-promoting layer comprises at least one of: iron[[;]] and titanium; ~~cobalt; nickel; tantalum; tungsten; niobium; zirconium; vanadium; chromium; and hafnium.~~

Claims 30-65 (canceled).

66. (Currently Amended) The method of claim 1, comprising:
providing the substrate with a first surface having a mask disposed thereon, the mask having openings through which areas of the first surface are exposed;
immersing the at least one electrode and the masked substrate in the suspension;
applying the direct or alternating current to the electrode and the masked substrate thereby creating an electrical field therebetween, the ~~nanostucture-containing material~~ carbon nanotubes and the adhesion promoting material being caused to migrate toward, and attach to, those exposed areas on the first surface of the substrate; and
removing the mask;
wherein a pattern of ~~nanostucture-containing material~~ the composite layer is deposited onto the substrate.

Claims 67 to 69 (Canceled)

70. (Previously Presented) The method of claim 66, wherein the electrical field applied between the two electrodes is in the range of 0.1 - 1000V/cm and the direct current is in the range of 0.1 – 200mA/cm².

71. (Currently Amended) The method of claim 66, comprising:
 adding additional materials into the suspension, the additional materials comprising at least one binder material, wherein the binder material is present in an amount ranging from 0.1-20 weight% of the ~~nanostucture-containing materials~~ carbon nanotubes.

72. (Currently Amended) The method of claim 71, wherein the binder material is at least one of poly(vinyl butyral-co vinyl alcohol-co-vinyl acetate) and poly(vinylidene fluoride).

73. (Currently Amended) The method of claim 71, wherein the ~~additional materials comprise~~ adhesion promoting material comprises small particles of at least one of: iron; titanium; lead; tin; or cobalt; and wherein the particles have a diameter less than 1 micrometer.

74. (Currently Amended) A method of depositing a ~~nanostucture-containing~~ composite film with at least one component being a nanostructured material onto a substrate, the method comprising:

forming a suspension of the ~~pre-formed nanostucture-containing~~ nanostructured material in a liquid medium, the ~~nanostucture-containing~~ nanostructured material comprising at least one of nanotubes and nanowires;

adding small particles to the suspension to promote adhesion of the ~~nanostucture-containing~~ nanostructured material to the substrate;

selectively adding a charger to the liquid medium;

immersing electrodes in the suspension, wherein at least one of the electrodes comprises the substrate; and

applying a direct or alternating current to the immersed electrodes thereby creating an electrical field between the electrodes;

wherein the ~~nanostucture-containing~~ nanostructured material and the small particles ~~is caused to migrate toward, and attach to,~~ co-deposit on the substrate to form a composite layer, the composite layer having an intimate mix of the carbon nanotubes and the adhesion-promoting material.

75. (New) The method of claim 74, wherein the small particles are metallic and have a diameter less than 1 micrometer.

76. (New) The method of claim 75, comprising shortening the carbon nanotubes by chemical reaction prior to their introduction into the suspension.

77. (New) The method of claim 75, comprising:
adding additional materials into the suspension, the additional materials comprising at least one binder material, wherein the binder material is present in an amount ranging from 0.1-20 weight% of the nanostructured material.

78. (New) The method of claim 75, wherein the small particles comprise a metal selected from the group consisting of: iron, titanium, lead, tin, and cobalt.

79. (New) An electrophoretic method of fabricating a carbon nanotube-based electron field emission cathode, the method comprising:
chemically processing carbon nanotubes to improve their dispersion in a liquid medium, the liquid medium comprising water and alcohol;
forming a suspension of the processed carbon nanotubes in the liquid medium;
adding an adhesion-promoting particle and a charger to the said suspension to form an intimate mixture;
immersing a plurality of electrodes in the mixture, wherein at least one of the electrodes comprises a field emission cathode substrate; and
applying a direct or alternating current to the immersed electrodes thereby creating an electrical field between the electrodes; wherein the carbon nanotubes and the adhesion-promoting particle co-deposit on pre-determined areas on the substrate to form a composite film, the composite film having an intimate mix of the carbon nanotubes and the adhesion-promoting particle; and
annealing the said field emission substrate with the deposited composite film at a pre-determined temperature to activate the adhesion-promoting particle such that they bond with the carbon nanotubes and the substrate.

80 (New) The method of claim 79, wherein the step of chemically processing the carbon nanotubes comprises adding chemical groups onto an outer wall of the carbon nanotubes so that they form a stable suspension in an electrophoresis bath.

81 (New) The method of claim 79, wherein the step of chemically processing the carbon nanotubes comprises shortening a length of the carbon nanotubes to a range of 1 to 10 micrometers.

82. (New) The method of claim 79, wherein a thickness of the composite film deposited on the substrate surface is in a range of 1 to 20 micrometers.

83. (New) A carbon nanotube-based field emission cathode fabricated by the method of claim 79.

84. (New) The carbon nanotube-based field emission cathode of claim 83, wherein the carbon nanotube-based field emission cathode has a field emission current density of $0.01\text{mA}/\text{cm}^2$ or higher at an applied electrical field of $1.4\text{V}/\text{micrometer}$ or lower.

85. (New) The method of claim 79, wherein the adhesion-promoting particle comprises small particles with a diameter less than 1 micrometer.

86. (New) An electrophoretic method of fabricating a carbon nanotube-based electron field emission cathode, the method comprising:

chemically processing carbon nanotubes to improve their dispersion in a medium of water and alcohol medium;

forming a suspension of the processed carbon nanotubes in the medium;

adding an adhesion-promoting particle and a charger to the said suspension to form an intimate mixture;

immersing electrodes in the mixture, wherein at least one of the electrodes comprises the field emission cathode substrate; and

applying a direct or alternating current to the immersed electrodes thereby creating an electrical field between the electrodes; wherein the carbon nanotubes and the adhesion-promoting particle co-deposit on pre-determined areas on the substrate to form a composite layer, the composite layer having an intimate mix of the carbon nanotubes and the adhesion-promoting particle; and

annealing the said field emission substrate with the deposited composite layer at a pre-determined temperature to activate the adhesion-promoting materials such that they bond with the carbon nanotubes and the substrate.

87 (New) The method of claim 86, wherein the step of chemically processing the carbon nanotubes comprises adding chemical groups onto an outer wall of the carbon nanotube so that they form a stable suspension in an electrophoresis bath.

88 (New) The method of claim 86, wherein the step of chemically processing the carbon nanotubes comprises shortening a length of the carbon nanotubes to a range of 1 to 10 micrometers.

89. (New) The method of claim 86, wherein a thickness of the composite layer deposited on the substrate surface is in a range of 1 to 20 micrometers.

90. (New) A carbon nanotube-based field emission cathode fabricated by the method of claim 86.

91. (New) The carbon nanotube-based field emission cathode of claim 90, wherein the carbon nanotube-based field emission cathode has a field emission current density of $0.01\text{mA}/\text{cm}^2$ or higher at an applied electrical field of $1.4\text{V}/\text{micrometer}$ or lower.

92. (New) The method of claim 86, wherein the method further comprises the following steps:

placing a mask on a surface of the cathode substrate, the mask having multiple openings through which areas of the cathode substrate are exposed to the mixture;

applying a direct current between the electrodes such that the mixture containing the carbon nanotubes and the adhesion promoting materials co-deposit onto the exposed cathode substrate areas; and

removing the mask without removing the composite layer.

93. (New) The method of claim 92, wherein the mask comprises a layer of developed photoresist.

94. (New) The method of claim 86, wherein the field emission cathode has a triode structure with a substrate, a dielectric insulating layer and a conducting layer; wherein the dielectric layer and the conducting layer have multiple openings through which areas of the cathode substrate are exposed.

95. (New) The method of claim 94, wherein a bias voltage is applied to the conducting layer during the electrophoretic deposition to prevent deposition of the carbon nanotubes on a surface of the conducting layer and to enable deposition of onto the exposed areas of the substrate.

96. (New) A sequential electrophoretic deposition method of fabricating carbon nanotube-based electron field emission cathodes, the method comprising:

forming multiple electrophoretic baths, wherein the multiple electrophoretic baths include a first bath and a second bath, wherein the first bath is a suspension comprising an adhesion promoting material and a charger in a liquid medium and the second bath is a suspension comprising carbon nanotubes and the charger in a mixture of alcohol and water;

immersing a plurality of electrodes in the first bath, wherein at least one of the electrodes comprises a field emission cathode substrate;

electrophoretically depositing a layer of the adhesion promoting material with a pre-determined thickness onto an exposed area of the cathode surface;

removing the plurality of electrodes from the first bath and immersing the plurality of electrodes in the second bath;

electrophoretically depositing a composite film including the carbon nanotubes on the exposed area of the cathode surface;

optionally repeating the steps of immersing and electrophoretically depositing in the first bath and the second bath; and

annealing the said field emission cathode substrate with the deposited composite film at a pre-determined temperature to activate the adhesion-promoting material such that they bond with the carbon nanotubes and the substrate.

97. (New) A carbon nanotube field emission cathode fabricated by the method of claim 96, wherein the cathode has a field emission current density of $0.01\text{mA}/\text{cm}^2$ or higher at an applied electrical field of $1.4\text{V}/\text{micrometer}$ or lower.